(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 681 361 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent: 08.09.1999 Bulletin 1999/36

(51) Int Cl.[6]: H02K 19/36

(21) Application number: 95102065.0

(22) Date of filing: 15.02.1995

(54) Synchronous machine with higher harmonics absorption function

Synchronmaschine mit Oberwellen-Dämpfungsfunktion

Machine synchrone absorbant les harmoniques élevées

(84) Designated Contracting States:
DE FR GB

(30) Priority: 15.02.1994 JP 1770894

(43) Date of publication of application:
08.11.1995 Bulletin 1995/45

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Description

[0001] The present invention relates to a rotating field synchronous machine according to the introductory part of claim 1.

[0002] The present invention moreover relates to a synchronous machine connected to an alternating current electric power transmitting or distributing system, and more specifically to an alternating current synchronous machine which facilitates absorbing specific higher harmonics superimposed on a fundamental wave voltage of a connected alternating current system (AC system).

Description of the Prior Art

[0003] Synchronous machines are widely used for generators in power stations, constant speed motors, etc. Therefore, the synchronous machines are in most cases directly connected to AC systems.

[0004] On the other hand, also connected to the AC systems are a number of power converters and rectifiers provided with electric power thyristors, etc. which may cause higher harmonics. These higher harmonics have the frequency n times higher than the fundamental AC wave voltage of the system, are harmful to electric devices connected to the system, and can invite malfunctions in communications devices in the vicinity. Under such conditions; there is the serious problem that these higher harmonics should be successfully removed from the AC systems. The above described synchronous machine is provided with a damper winding to absorb higher harmonics generated in the AC system. That is, the damper winding is provided on the pole face of the magnetic pole of the synchronous machine. Practically, plural slots are made on the magnetic pole and filled with damper bars to form a cage type conductor by short-circuiting both ends of the damper bars. This configuration is normally used to reduce the fluctuation of the internal phase angle caused by a sudden change of load. Additionally, it has the function of absorbing higher harmonics by supplying an induced current which reduces a magnetic field generated on an armature by a higher harmonic current. That is, if a higher harmonic current flows through the armature of a synchronous machine from the AC system connected to the armature, then a higher harmonic magnetic field is generated asynchronous with the fundamental AC wave. This magnetic field generates an induced current through the damper winding, which reduces the higher harmonic magnetic field, and absorbs the higher harmonic current.

[0005] As described above, the higher harmonics are absorbed by the damper winding by causing the induced current through the damper winding to reduce the higher harmonic magnetic field generated on an armature winding. The damper winding, which is composed of a damper bar and a short-circuit conductor, generates a large leakage inductance, which allows insufficient induced current. Therefore, the asynchronous higher harmonic magnetic field generated by the higher harmonic current from the AC system cannot be completely reduced. As a result, the above described damper winding has failed in sufficiently reducing higher harmonics.

[0006] From EP-A-0 117 764 a coil device is known which comprises an insulator inserted in the coil. Furthermore a coil device is shown constituted by winding an insulator film around the coil. That means that a capacity element is present between the coil turns and the coil device functions as a low-pass filter to the quantity of eletricity (voltage, current, charge) which varies rapidly, by the combination of the absorption of a capacitance of the capacity element, as well as the blockage of an inductance of the coil. Thus, the known device functions as (1) a reactor for absorbing the switching surge voltage of a rectifier circuit and as (2) a coil for absorbing a transient induction voltage from an armature coil side to a field coil side, at the time of the field blockage or pull-out occurrence.

[0007] From DE-C 270002 an embodiment is known where a capacitor is connected to a coil wound around a magnetic pole, representing a field coil at the magnetic pole of a synchronous motor.

[0008] The present invention relates to an alternating current synchronous machine (AC synchronous machine) which facilitates absorbing specific higher harmonics superimposed on a fundamental AC wave voltage of an alternating current system (AC system) to which the AC synchronous machine is linked.

[0009] In the AC synchronous machine, provided with such a higher harmonics absorption function according to the prior art, field winding and damper winding, which damper winding is further constructed in a cage-type winding formed by short-circuiting both ends of damper bars disposed in slots on a pole face, are arranged on the magnetic poles.

[0010] The object of the present invention is achieved by a rotating field synchronous machine comprising magnetic poles; a damper winding disposed on each of the magnetic poles, which damper winding being divided into a predetermined number of winding divisions, each thereof having predetermined winding turns; and capacitors, each of which being connected in parallel with each of the winding division; to enable a resonant circuit to be comprised of said capacitor and said damper winding division, characterised in that a first resonant circuit, which is comprised of the said resonant circuits resonates at a specific resonant frequency, said specific frequency is set at a frequency 6n times as high as a fundamental frequency of said synchronous machine or $(6n \pm 1)$ times this fundamental frequency, wherein n is a positive integer.

[0011] In a further preferred embodiment said capacitors are disposed on an external stationary side of said synchronous machine and connected with said damper winding divisions through pairing slip rings and brushes.

[0012] Another embodiment is characterized in that

the said capacitors are connected through parallel circuits of a reactor and a capacitor with said damper winding divisions.

[0013] The rotating field synchronous machine of a second embodiment is comprising magnetic poles, field winding disposed on said magnetic poles, a DC reactor for blocking flowing-in of higher harmonics to a DC excitation power supply, and a capacitor connected in parallel with said field winding on the field winding side of said DC reactor, thereby enabling a series resonant circuit to be comprised of said capacitor and said field winding, so that said series resonant circuit resonates at a specific resonant frequency, and is characterised in that said specific resonant frequency is set at a frequency 6n times as high as a fundamental frequency of said synchronous machine, wherein n is a positive integer.

[0014] Another embodiment is characterized in that the said capacitor is connected through a parallel circuit of a reactor and a capacitor with said field winding.

[0015] A preferred embodiment of the present invention a rotating field synchronous machine comprises further

a field winding disposed on said magnetic poles;

a second capacitor connected in parallel with said field winding; and

a second series resonant circuit, further comprising said second capacitor and said field winding, for resonating at a further specific resonant frequency, characterised in that said further specific resonant frequency is set at a frequency equal to the resonant frequency of the first resonant circuit.

[0016] A further embodiment of the present invention is characterised in that said first capacitors are disposed on an external stationary side of said synchronous machine and connected with said damper winding through pairing slip rings and brushes.

[0017] A further embodiment is characterised in that said first capacitors are connected through parallel circuits of a reactor and a capacitor with said damper winding, and said second capacitor is connected through a parallel circuit of a reactor and a capacitor with said field winding.

Brief Description of the Drawings

[0018]

Figure 1 is a circuit diagram of an embodiment of a rotating field synchronous machine with two salient poles and with brushes according to the present invention;
Figure 2 is a circuit diagram of another embodiment of a rotating field cylindrical rotor brush-less synchronous machine according to the present invention; and
Figure 3 is a circuit diagram of an embodiment of a general AC synchronous machine (the third embodiment) according to the present invention.

Description of the Preferred Embodiment

[0019] Hereinafter the present invention will be described in detail hereinafter with accompanied drawings Figures 1 through 3, which illustrate the preferred embodiments of the present invention. In Figures 1, 2 and 3, the constituents having the same function are designated by the same reference numerals.

[0020] Figure 1 is a circuit diagram of an embodiment of a rotating field synchronous machine with two salient poles and with brushes.

[0021] In Figure 1, a reference numeral 1 designates a field winding of the synchronous machine; 2 a damper winding comprising an independent closed circuit arranged in a plurality of slots disposed on a pole face of a magnetic pole 4; and 3 a capacitor for resonance connected in parallel with a division of the damper winding obtained by dividing the damper winding 2 at every predetermined number of winding turns. Although three damper windings 2 are shown in Figure 1, a number of damper windings are mounted in a section, each being connected to a single capacitor 3. Each element enclosed by a single-dotted chain line forms a rotating portion mounted on the stator of the synchronous machine.

[0022] Therefore, side faces 4a and 4b of the above described magnetic pole 4 are provided with armatures (not shown in the drawings) at predetermined intervals, each armature being connected to an AC system.

[0023] The Slip rings 5a connect with the pair of brushes 5b, supported by the stator of the synchronous machine; a capacitor 6 is connected in parallel with the field winding 1 through brushes 5b and slip rings 5a; a direct current reactor 7 prevents higher harmonics; and a direct current power source 8 supplies the field winding 1 with a direct excitation current. These constituent elements surrounded by a single-dotted chain line in the figure are arranged on the outer stationary side of the synchronous machine.

[0024] A closed circuit comprised of the damper winding 2 and the capacitors 3 of the above described synchronous machine forms a series resonant circuit for a specific frequency. That is, the inductance value of the damper winding 1 and the capacitance of the capacitor 3 are properly set to form a series resonant circuit with an impedance of 0 at the specific resonant frequency. When an induced current flows at a specified frequency, the circuit impedance of the damper winding 2 is approximately 0, thereby allowing a larger induced current to flow through the damper winding. For example, if the specified frequency refers to higher harmonics ($6n \pm 1$) f (where f indicates a fundamental AC wave frequency) as being the most significant higher harmonic components), then the inductance value of the damper winding

2 and the capacitance of the capacitor 3 are set for resonance with this frequency. Thus, an induced current flows through the damper winding 2 and reduces the higher harmonic magnetic field by the 5th and 7th higher harmonics (n=6 having the largest influence on the fundamental AC wave) from the fundamental wave. The impedance of the induced current is low enough to completely reduce the higher harmonic magnetic field. Likewise, in the series resonant circuit comprising the field winding 1 and the capacitor 6, properly setting the inductance value of the field winding 1 and the capacitance of the capacitor 6 sets the impedance to 1 for the higher harmonic components, thereby reducing the higher harmonic magnetic field generated in the armature. Thus, the two above described series resonant circuits can reduce the asynchronous higher harmonic magnetic field generated at the armature winding and completely absorb the higher harmonics (for example the 5th and 7th higher harmonics) contained in the AC system.

[0025] Figure 2 is a circuit diagram of an embodiment of a rotating field cylindrical rotor brush-less synchronous machine.

[0026] In Figure 2, reference numerals 1 and 2 designate a field winding and a damper winding which are schematically shown by symbols [circle] and [square] in the figure, respectively. Symbols [·] and [X] included in the symbols [circle] and [square], indicate respectively the directions of the current flowing out and in through the illustrated cross section. Reference numerals 3 and 11 designate respectively a capacitor for resonance and a varistor connected in parallel with the damper winding 2; and 6 and 12 a capacitor for resonance and a varistor respectively connected in parallel with the field winding 1. A pair of the capacitor 3 and the varistor 11 is schematically shown in figure 2 solely for simplicity.

[0027] A reference numeral 14 designates an armature of a rotating armature type AC exciter, driven on a shaft common with a rotor of the synchronous machine. Output voltage of the armature 14 is controlled by an excitation regulating apparatus (not shown) disposed outside the synchronous machine. A reference numeral 13 designates a rectifier (rotating rectifier) disposed on the rotor of the synchronous machine. The output from the armature of the AC exciter is rectified by the rectifier 13 and supplied to the field winding 1 of the synchronous machine through a DC reactor 7, for blocking higher harmonics. That is, a field current of a synchronous machine is supplied by a direct current exciter, which removes the need for brushes 5b and slip rings 5a as shown in Fig. 1. Therefore, the field current can be made variable by adjusting the excitation current provided to the direct current exciter.

[0028] In the embodiment shown in figure 2, a series resonant circuit comprised of the damper winding 2 and the capacitor 3 and a series resonant circuit comprised of the field winding 1 and the capacitor 6 have the same resonant frequency. The resonant frequency is set at 6nf corresponding to the most significant higher harmonic components (6n ± 1)f.

[0029] The first closed circuit comprising the damper winding 2 and the capacitor 3 of the synchronous machine with the above described configuration and the second series resonant circuit comprising the field winding 1 and the capacitor 6, indicate the impedance of approximately 0 for a specified frequency, thereby allowing a large induced current to flow through the damper winding. For example, if the specified frequency refers to the higher harmonics f (6n ± 1, where f indicates a fundamental AC wave frequency) as the most significant higher harmonic components, then the induced current which is resonant with the frequency and which reduces the higher harmonic magnetic field through the 5th and 7th higher harmonics (n=6 having the largest influence on the fundamental AC wave) is made to flow through the field winding 1 and the damper winding 2, to reduce the higher harmonics generated in the armature and to absorb the higher harmonics in the AC system.

[0030] When the series resonant circuit of the damper winding 2 and the capacitor 3 has been brought into its state of resonance, and the induced current due to the higher harmonics on the AC system side has increased the charge on capacitor 3 so much as to boost the terminal voltage of the capacitor 3 beyond a predetermined value, the varistor 11 becomes conductive to lower the Q value of the resonant circuit, so as to suppress the aforementioned induced current. The varistor 12 functions in a similar manner as the varistor 11.

[0031] The varistors 11, 12 may be replaced by voltage regulation diodes or discharge gaps which function similarly.

[0032] Figure 3 is a circuit diagram of an embodiment of a general AC synchronous machine.

[0033] As shown in Figure 3, a parallel-series circuit, comprised of a parallel circuit of an AC reactor 9 and a capacitor 10, to which a capacitor 6 is connected in series, is connected in parallel with a field winding 1 of the synchronous machine for blocking the higher harmonic components of the system side in the field winding 1.

[0034] There are two resonant frequencies in the field circuit having the above described circuit configuration. By properly selecting the constants of the constituent elements of the field winding circuit, the above described two resonant frequencies can be set at the frequencies in accordance with the two most significant components of the higher harmonics of the AC system so that the frequency range, in which the higher harmonics of the AC system should be reduced, may be expanded.

[0035] For example, by setting the inductance of the field winding 1 and the reactor 2 at 24 mH and 10mH respectively, the static capacitance of the capacitors 6 and 10 at 4.7μF and 8.5μF respectively, and the inductance of the DC reactor 7 at a large enough value, the aforementioned field winding circuit has two resonant frequencies of 360 Hz and 720 Hz, which correspond to

the sixth and the twelfth higher harmonics of the AC synchronous machines, the rated frequency of which is 60 Hz.

[0036] Therefore the impedance, seen from the armature side of the synchronous machine, for the fifth, seventh, eleventh and thirteenth higher harmonics, significant in the AC system, becomes extremely low. Thus, the above described higher harmonics on the AC system side can satisfactorily be absorbed by the synchronous machine of the third embodiment.

[0037] The circuit configuration which obtains two resonant frequencies, for absorbing the higher harmonic components of the system side, by connecting, as shown in Figure 3, a filter circuit comprised of the capacitors 3 and 10, and the reactor 9 with the field winding 1, is applicable to the damper winding 2. This circuit configuration is also applicable to synchronous machines irrespective of whether or not they are brush-less.

[0038] As has been explained so far, according to the present invention, the impedance of either one or both of the damper winding and the field winding circuits for the most significant (6n ± 1)th higher harmonics on the system side, for example the fifth, the seventh, the eleventh and the thirteenth, are greatly reduced, and the (6n ± 1)th higher harmonics on the system side are reduced by flowing a sufficient induced current in either one or both of the damper winding and the field winding, which induced current interlinks and cancels the asynchronous higher harmonic magnetic field generated by the armature of the synchronous machine. That is, the higher harmonics on the system side are absorbed by the synchronous machine according to the present invention;

(1) by forming a series resonant circuit with a damper winding divided at a predetermined number of winding turns into winding divisions with capacitors, each of which is connected in parallel with each of the winding divisions; or

(2) by forming a series resonant circuit with a field winding and with a capacitor connected in parallel with the field winding; or

(3) by forming the first series resonant circuit with a damper winding divided at a predetermined number of winding turns into winding divisions with the first capacitors, each of which is connected in parallel with each of the winding divisions, and the second series resonant circuit with a field winding with the second capacitor, connected in parallel with the field winding; and by setting the resonant frequencies of the first and the second resonant circuits at the same frequency; and

(4) by setting either one of the resonant frequencies or each of the first and the second resonant frequencies at the frequency 6nf of the 6nth harmonic wave (n: a positive integer, and f: a fundamental frequency) corresponding to the most significant higher harmonics in the AC system to be absorbed; or

(5) by connecting the capacitors with the damper winding through parallel circuits of a reactor and a capacitor, by connecting the capacitor with the field winding through a parallel circuit of a reactor and a capacitor, or by connecting the first and the second capacitors with the damper winding and the field winding through parallel circuits of a reactor and a capacitor, and by providing with two resonant frequencies.

When the capacitors connected with the damper winding can practically be mounted on the rotor of the synchronous machine,

(6) by mounting the capacitors on the rotor of the synchronous machine, the slip rings and the brushes, which would be necessary for coupling capacitors mounted on the external stationary side of the synchronous machine with the damper winding, can be eliminated.

When it is not appropriate to mount the capacitors connected with the damper winding on the rotor of the synchronous machine,

(7) a series resonant circuit may be formed without any problems by mounting the capacitors on the external stationary side of the synchronous machine and by connecting the capacitors with the damper winding through slip rings and brushes.

When the capacitors connected with the damper winding and the capacitor connected with the field winding can practically be mounted on the rotor of the synchronous machine,

(8) the synchronous machine may be comprised of a brush-less synchronous machine, and the slip rings and the brushes may be eliminated by mounting the capacitors of the resonant circuits on the rotor of the synchronous machine.

[0039] By constructing a synchronous machine as described above, an effective absorption function (extinction or reduction function of specific higher harmonic components on the AC system side) can be provided to the synchronous machine. When a brush-less synchronous machine can be used for the synchronous machine, cumbersome works such as inspection, maintenance, replacement of parts, etc, become unnecessary by the elimination of the slip rings and the brushes, and operating reliability of the synchronous machine is improved.

[0040] By the provision of the above described higher harmonics absorption measures according to the present invention, the synchronous machine can be down-sized when compared with the conventional synchronous machine, which presumes flowing-in of the higher harmonics. The present higher harmonics absorption measures can be used for the substitution of expensive active filters.

Claims

1. A rotating field synchronous machine comprising;

   magnetic poles;
   a damper winding (2) disposed on each of said magnetic poles (4), said damper winding (2) being divided into a predetermined number of winding divisions, each thereof having predetermined winding turns; and
   capacitors (3), each thereof being connected in parallel with each of said winding divisions to enable a resonant circuit to be comprised of said capacitor (3) and said damper winding division (2), characterised in that a first resonant circuit, which is comprised of the said resonant circuits, resonates at a specific resonant frequency,
   said specific resonant frequency is set at a frequency 6n times as high as a fundamental frequency of said synchronous machine or (6n $\pm$ 1) times this fundamental frequency wherein n is a positive integer.

2. The rotating field synchronous machine as claimed in claim 1, wherein said capacitors (3) are disposed on an external stationary side of said synchronous machine and connected with said damper winding divisions (2) through pairing slip rings and brushes.

3. The rotating field synchronous machine as claimed in claim 2, wherein said capacitors are connected through parallel circuits of a reactor and a capacitor with said damper winding divisions (2).

4. A rotating field synchronous machine comprising;

   magnetic poles (4);
   field winding (1) disposed on said magnetic poles (4);
   a DC reactor (7) for blocking flowing-in of higher harmonics to a DC excitation power supply (8); and
   a capacitor (6) connected in parallel with said field winding (1) on the field winding side of said DC reactor (7);
   thereby enabling a series resonant circuit to be comprised of said capacitor (6) and said field winding (1), so that said series resonant circuit resonates at a specific resonant frequency, characterised in that
   said specific resonant frequency is set at a frequency 6n times as high as a fundamental frequency of said synchronous machine, wherein n is a positive integer.

5. The rotating field synchronous machine as claimed in claim 4, wherein said capacitor (6) is connected through a parallel circuit of a reactor (9) and a capacitor (10) with said field winding (1).

6. A rotating field synchronous machine as claimed in claim 1 comprising;

   a field winding disposed on said magnetic poles (4);
   a second capacitor (6) connected in parallel with said field winding (1); and
   a second series resonant circuit, further comprising said second capacitor (6) and said field winding (1), for resonating at a further specific resonant frequency, characterised in that
   said further specific resonant frequency is set at a frequency equal to the resonant frequency of the first resonant circuit.

7. The rotating field synchronous machine as claimed in claim 6, wherein said first capacitors (3) are disposed on an external stationary side of said synchronous machine and connected with said damper winding (2) through pairing slip rings and brushes.

8. The rotating field synchronous machine as claimed in claim 7, wherein said first capacitors (3) are connected through parallel circuits of a reactor (9) and a capacitor (10) with said damper winding (2), and said second capacitor (6) is connected through a parallel circuit of a reactor (9) and a capacitor (10) with said field winding (1).

Patentansprüche

1. Drehfeldsynchronmaschine, die umfaßt:

   Magnetpole;

   eine Dämpferwicklung (2), die an jedem der Magnetpole (4) angeordnet ist, wobei die Dämpferwicklung (2) in eine vorbestimmte Anzahl von Wicklungsabteilungen unterteilt ist, von denen jede vorbestimmte Wicklungswindungen aufweist; und

   Kondensatoren (3), von denen jeder parallel mit jeder der Wicklungsabteilungen verbunden ist, um zu ermöglichen, daß eine Resonanzschaltung aus dem Kondensator (3) und der Dämpferwicklungsabteilung (2) gebildet wird, dadurch gekennzeichnet, daß die erste Resonanzschaltung, die aus den genannten Resonanzschaltungen besteht, bei einer spezifischen Resonanzfrequenz in Resonanz ist, wobei die spezifische Resonanzfrequenz bei einer Frequenz eingestellt wird, die 6n mal so hoch wie eine Grundfrequenz der Synchronmaschi-

ne oder (6n ± 1) mal diese Grundfrequenz ist, wobei n eine positive ganze Zahl darstellt.

2. Drehfeldsynchronmaschine nach Anspruch 1, bei der die Kondensatoren (3) auf einer äußeren stationären Seite der Synchronmaschine angeordnet sind und mit den Dämpferwicklungsabteilungen (2) durch paarige Schleifringe und -bürsten verbunden sind.

3. Drehfeldsynchronmaschine nach Anspruch 2, bei der die Kondensatoren durch Parallelschaltungen einer Drosselspule und eines Kondensators mit den Dämpferwicklungsabteilungen (2) verbunden sind.

4. Drehfeldsynchronmaschine, die umfaßt:

Magnetpole (4);

eine Feldwicklung (1), die an den Magnetpolen (4) angeordnet ist;

eine Gleichstromdrosselspule (7) zum Blockieren des Einfließens von höheren Oberschwingungen zu einer Gleichstromerregerenergieversorgung(8); und

einen Kondensator (6), der parallel mit der Feldwicklung (1) auf der Feldwicklungsseite der Gleichstromdrosselspule (7) verbunden ist;

wodurch ermöglicht wird, daß eine Reihenresonanzschaltung aus dem Kondensator (6) und der Feldwicklung (1) gebildet wird, so daß die Reihenresonanzschaltung bei einer spezifischen Resonanzfrequenz in Resonanz ist, dadurch gekennzeichnet, daß die spezifische Resonanzfrequenz bei einer Frequenz eingestellt wird, die 6n mal so hoch wie eine Grundfrequenz der Synchronmaschine ist, wobei n eine positive ganze Zahl darstellt.

5. Drehfeldsynchronmaschine nach Anspruch 4, bei der der Kondensator (6) durch eine Parallelschaltung einer Drosselspule (9) und eines Kondensators (10) mit der Feldwicklung (1) verbunden ist.

6. Drehfeldsynchronmaschine nach Anspruch 1, die umfaßt:

eine Feldwicklung, die an den Magnetpolen (4) angeordnet ist;

einen zweiten Kondensator (6), der parallel mit der Feldwicklung (1) verbunden ist; und

eine zweite Reihenresonanzschaltung, die weiter den zweiten Kondensator (6) und die Feldwicklung (1) zum in Resonanz bringen bei einer weiteren spezifischen Resonanzfrequenz aufweist, dadurch gekennzeichnet, daß die weitere spezifische Resonanzfrequenz bei einer Frequenz eingestellt wird, die gleich der Resonanzfrequenz der ersten Resonanzschaltung ist.

7. Drehfeldsynchronmaschine nach Anspruch 6, bei der die ersten Kondensatoren (3) auf einer äußeren stationären Seite der Synchronmaschine angeordnet und mit der Dämpferwicklung (2) durch gepaarte Gleitringe und -bürsten verbunden sind.

8. Drehfeldsynchronmaschine nach Anspruch 7, bei der die ersten Kondensatoren (3) durch Parallelschaltungen einer Drosselspule (9) und eines Kondensators (10) mit der Dämpferwicklung (2) verbunden sind, und der zweite Kondensator (6) durch eine Parallelschaltung einer Drosselschaltung (9) und eines Kondensators (10) mit der Feldwicklung (1) verbunden ist.

Revendications

1. Machine synchrone à champ tournant comprenant :

des pôles magnétiques ;
un enroulement d'amortissement (2) disposé sur chacun desdits pôles magnétiques (4), ledit enroulement d'amortissement (2) étant divisé en un nombre prédéterminé de divisions d'enroulement, dont chacune présente un nombre de tours d'enroulement prédéterminé ; et
des condensateurs (3), dont chacun est relié en parallèle avec chacune desdites divisions d'enroulement afin de permettre qu'un circuit résonant soit constitué dudit condensateur (3) et de ladite division d'enroulement d'amortissement (2), caractérisée en ce qu'un premier circuit résonant, qui comprend lesdits circuits résonants, résonne à une fréquence de résonance particulière, ladite fréquence de résonance particulière est réglée à une fréquence qui est 6n fois plus élevée que la fréquence fondamentale de ladite machine synchrone ou (6n ± 1) fois cette fréquence fondamentale, dans lequel n est un nombre entier positif.

2. Machine synchrone à champ tournant selon la revendication 1, dans laquelle lesdits condensateurs (3) sont disposés sur une face immobile externe de ladite machine synchrone et sont reliés auxdites divisions d'enroulement d'amortissement (2) par l'intermédiaire de bagues de collecteur et de balais appariés.

3. Machine synchrone à champ tournant selon la re-

vendication 2, dans laquelle lesdits condensateurs sont reliés par l'intermédiaire de circuits parallèles d'une réactance et d'un condensateur avec lesdites divisions d'enroulement d'amortissement (2).

4. Machine synchrone à champ tournant comprenant :

des pôles magnétiques (4) ;
un enroulement de champ (1) disposé sur lesdits pôles magnétiques (4) ;
une réactance en courant continu (7) destinée à bloquer la circulation des harmoniques plus élevés vers une alimentation d'excitation en courant continu (8) ; et
un condensateur (6) relié en parallèle avec ledit enroulement de champ (1) sur le côté d'enroulement de champ de ladite réactance en courant continu (7) ;
permettant ainsi qu'un circuit résonant série soit constitué dudit condensateur (6) et dudit enroulement de champ (1), de sorte que ledit circuit résonant série résonne à une fréquence de résonance particulière, caractérisée en ce que
ladite fréquence de résonance particulière est réglée à une fréquence 6n fois plus élevée que la fréquence fondamentale de ladite machine synchrone, dans lequel n est un nombre entier positif.

5. Machine synchrone à champ tournant selon la revendication 4, dans laquelle ledit condensateur (6) est relié par l'intermédiaire d'un circuit parallèle constitué d'une réactance (9) et d'un condensateur (10) audit enroulement de champ (1).

6. Machine synchrone à champ tournant selon la revendication 1, comprenant :

un enroulement de champ disposé sur lesdits pôles magnétiques (4) ;
un second condensateur (6) relié en parallèle avec ledit enroulement de champ (1) ; et
un second circuit résonant série, comprenant en outre ledit second condensateur (6) et ledit enroulement de champ (1), afin de résonner à une autre fréquence de résonance particulière, caractérisée en ce que
ladite autre fréquence de résonance particulière est réglée à une fréquence égale à la fréquence de résonance du premier circuit résonant.

7. Machine synchrone à champ tournant selon la revendication 6, dans laquelle lesdits premiers condensateurs (3) sont disposés sur une face immobile externe de ladite machine synchrone et reliés auxdits enroulements d'amortissement (2) par l'intermédiaire de bagues de collecteur et de balais appariés.

8. Machine synchrone à champ tournant selon la revendication 7, dans laquelle lesdits premiers condensateurs (3) sont reliés par l'intermédiaire de circuits parallèles comprenant une réactance (9) et un condensateur (10) audit enroulement d'amortissement (2), et ledit second condensateur (6) est relié par l'intermédiaire d'un circuit parallèle comprenant une réactance (9) et un condensateur (10) audit enroulement de champ (1).

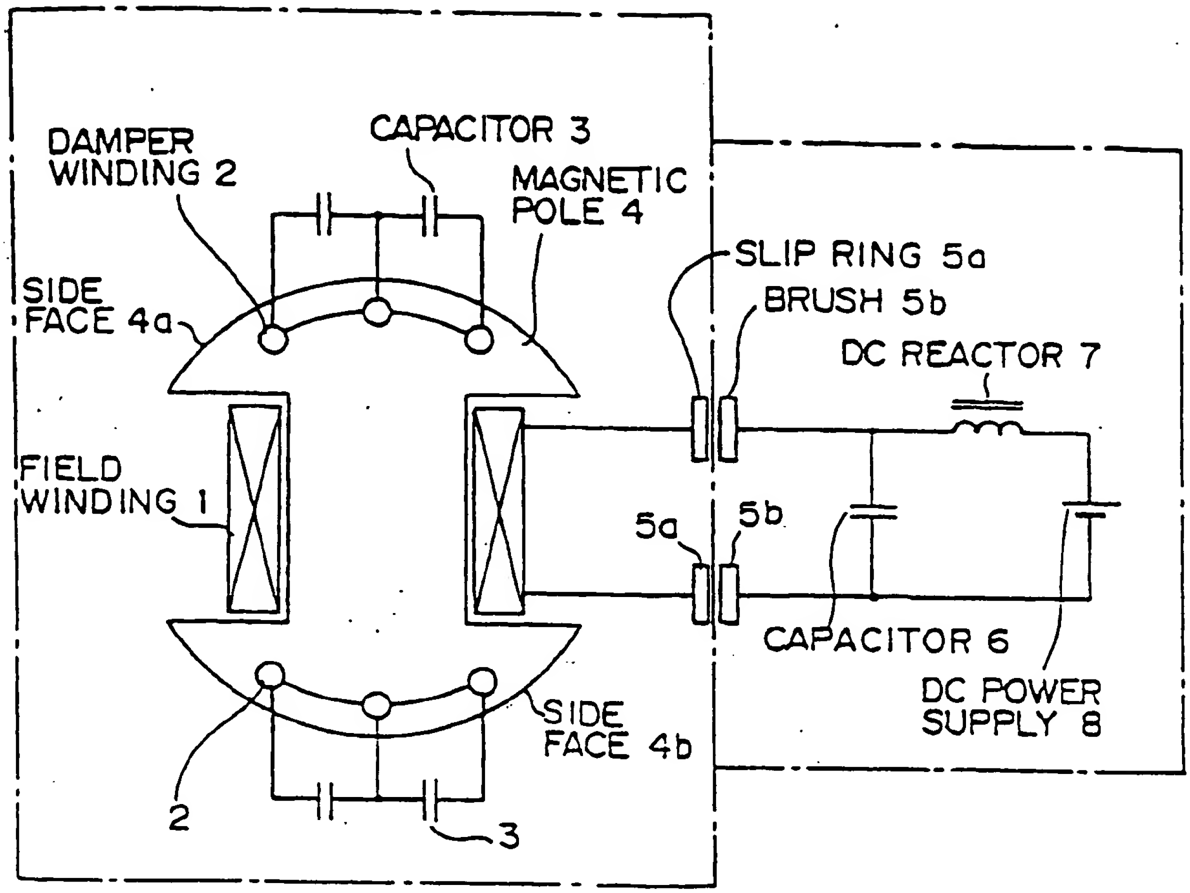
CAPACITOR 3
DAMPER WINDING 2
MAGNETIC POLE 4
SLIP RING 5a
BRUSH 5b
SIDE FACE 4a
DC REACTOR 7
FIELD WINDING 1
5a
5b
CAPACITOR 6
DC POWER SUPPLY 8
SIDE FACE 4b
2
3

Fig. 1

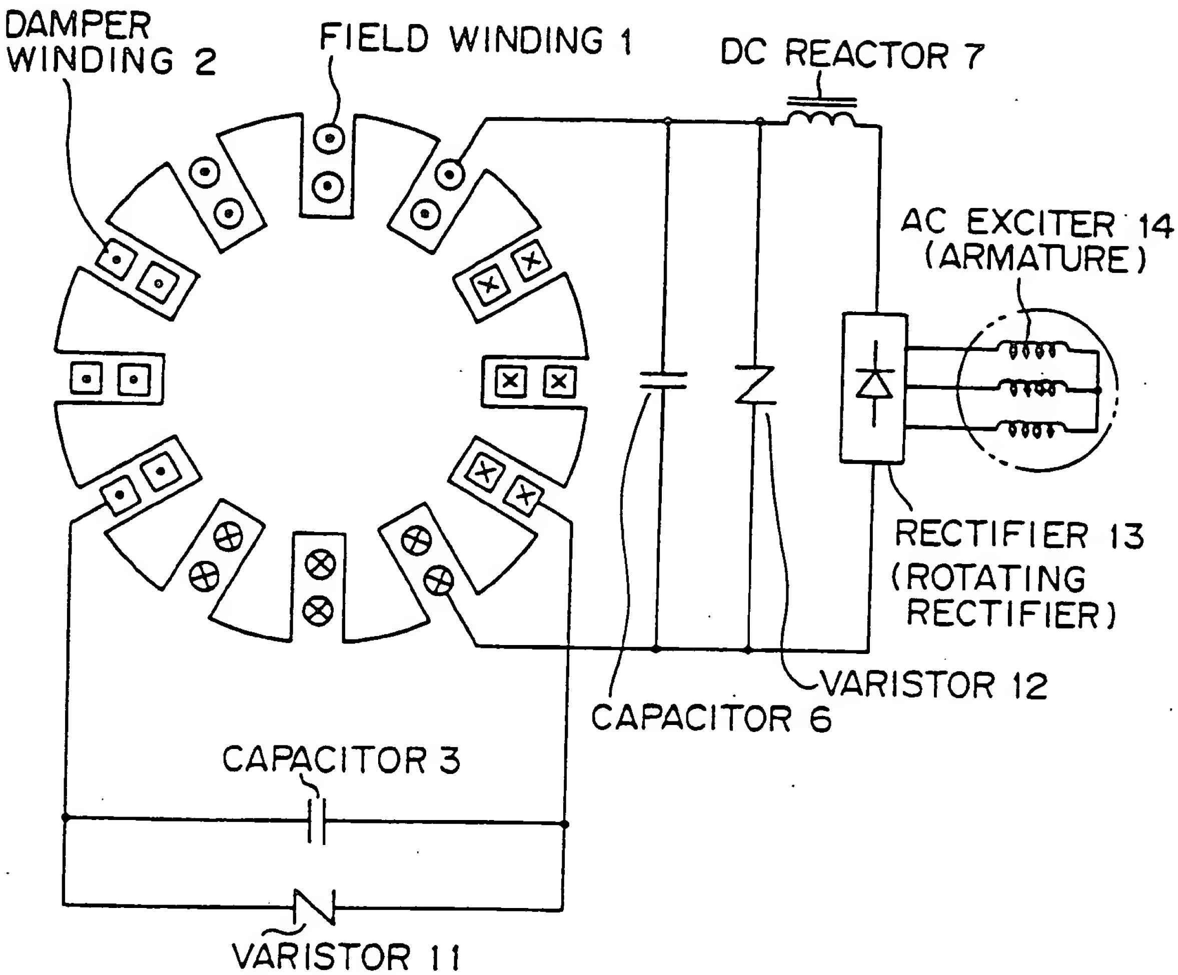
DAMPER WINDING 2
FIELD WINDING 1
DC REACTOR 7
AC EXCITER 14 (ARMATURE)
RECTIFIER 13 (ROTATING RECTIFIER)
VARISTOR 12
CAPACITOR 6
CAPACITOR 3
VARISTOR 11

Fig. 2

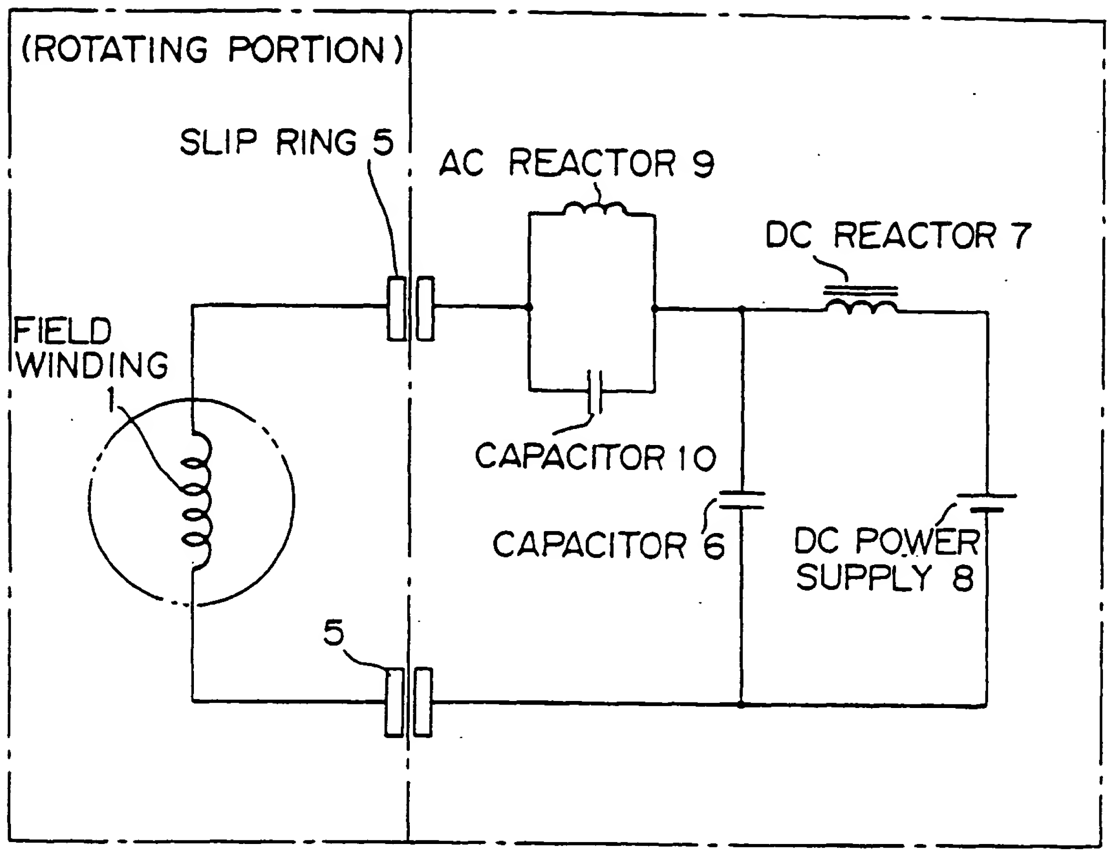
(ROTATING PORTION)
SLIP RING 5
AC REACTOR 9
DC REACTOR 7
FIELD WINDING 1
CAPACITOR 10
CAPACITOR 6
DC POWER SUPPLY 8
5

Fig. 3